

POST GRADUATE COURSES

(Ph.D.)

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UNIVERSITY OF VETERINARY AND
ANIMAL SCIENCES LAHORE

Department of Animal Nutrition

Courses for Ph.D.

Course No.	Course Title	Credit hours
1031	Animal Nutrition and Physiology	4(4-0)
1032	Energy Metabolism	3(2-1)
1033	Nutrition of Layers	3(2-1)
1034	Nutrition of Beef Animals	3(2-1)
1035	Vitamins in Animal Nutrition	2(2-0)
1036	Nutrition of Indigenous and Rural Poultry	3(2-1)
1037	Equine Nutrition	2(2-0)
1038	Camel Nutrition	2(2-0)
1039	Fish Nutrition	2(2-0)
1040	Feed Biotechnology	2(2-0)
1041	Nutrition of Pet and Zoo Animals	3(2-1)
1042	Advance analytical techniques in Animal Nutrition	3(0-3)

Course Title: Animal Nutrition and Physiology

Course No: NUTR-1031

Course Duration: 1 semester (16 weeks)

Credit hours: 4(4-0)

Course Description

This course has been designed for understanding of different functions, digestion mechanisms and utilization of different nutrients in different types of animals. Working of different biological cycles and end-products produced in result of catabolism. Understanding of different metabolic disorders related with different nutrients will also be part of this course.

Course Goals and performance Objectives

Objective 1

To understand the nutritional physiology of major nutrients

Objective 2

To learn about digestion and metabolism of major nutrients

Objective 3

Metabolic disorders related with improper utilization of nutrients

Course Contents

Theory:

Importance of essential nutrients and their functions. Comparative digestive physiology of ruminants and non-ruminants. Digestion and absorption of carbohydrate in ruminants and non-ruminants. Effect of structure of starch on digestion. Digestion of milk and plant sources. Extracellular hydrolysis of complex carbohydrates. Digestion and absorption of lipids in ruminants and simple stomach animals. Fatty acid (FA) synthesis in tissues. Production and utilization of ketone bodies. Digestion and absorption of proteins in ruminants and non-ruminants. Digestion and absorption of vitamins in different species. Quasi vitamins in animal nutrition. Minerals, their digestion and metabolism. Biological cycles involve in metabolism. Hormonal control of metabolism. Extremophile and eicosanoid metabolism. Major metabolic disorders in ruminants and simple stomach animals. Importance of water in animal nutrition.

Detail Course Outline

Serial No	Theory	Serial No	Theory
01	Introduction to chemistry of essential nutrients	33	Digestion of proteins in non-ruminants

02	Importance of functions of essential nutrients	34	Absorption of proteins in ruminants
03	Comparative digestive physiology of ruminants	35	Absorption of proteins in mono gastric species
04	Comparative digestive physiology of non-ruminants	36	Interconversion of nutrients in ruminants
05	Chemistry of proteins	37	Interconversion of nutrients in poultry
06	Chemistry of carbohydrates	38	Protein synthesis
07	Chemistry of fats	39	Water and its importance for poultry birds
08	Digestion of carbohydrates in simple stomach animals	40	Water and its importance for ruminants
09	Absorption of carbohydrate in simple stomach animals	41	digestion of fat soluble vitamins in ruminants
10	Digestion of simple carbohydrates in ruminants	42	digestion of water soluble vitamins for ruminants
11	Digestion of complex carbohydrates in ruminants	43	digestion of water soluble vitamins for non-ruminants
12	Absorption of simple and complex carbohydrates in ruminants	44	digestion of fat soluble vitamins in non-ruminants
13	Effect of structure of starch on digestion	45	Utilisation of macro minerals in ruminants
14	Substrate specificity and developmental changes of carbohydrates in non-ruminants	46	Utilisation of micro minerals in ruminants
15	Digestion of milk and plant sources	47	Utilisation of macro minerals in non-ruminants
16	Trafficking of monosaccharides from small intestine to liver	48	Utilisation of micro minerals in non-ruminants
17	Extra cellular hydrolysis of complex carbohydrates	49	Quasi vitamins in animal nutrition
18	Digestion of glycerol lipid substances in ruminants	50	Biological cycles involved in metabolism of fats in ruminants
19	Digestion of non-glycerol lipid substances in ruminants	51	Biological cycles involved in metabolism of fats in non-ruminants
20	Digestion of glycerol lipid substances in non-ruminants	52	Biological cycles involved in metabolism of fats in ruminants
21	Digestion of glycerol lipid substances in non-ruminants	53	Biological cycles involved in metabolism of carbohydrates in non-ruminants
22	Absorption of lipids in ruminants	54	Biological cycles involved in carbohydrates metabolism in large animals
23	Absorption of lipids in mono gastric species	55	Biological cycles involved in protein metabolism in large animals
24	Fatty acid synthesis and role of hormones	56	Biological cycles involved in metabolism of proteins in non-ruminants

25	Fatty acid synthesis and role of hormones	57	Extremophile metabolism of non-ruminants
26	Importance of essential fatty acids in animal body	58	Extremophile metabolism of ruminants
27	Production of ketone bodies	59	Eicosanoid metabolism in ruminants
28	Utilisation of ketone bodies	60	Eicosanoid metabolism in non-ruminants
29	Digestion of proteins in ruminants	61	Hormonal control of metabolism
30	Digestion of proteins in ruminants	62	Hormonal control of metabolism
31	Utilization of NPN substances in ruminants	63	Major metabolic disorders in ruminants
32	Digestion of proteins in non-ruminants	64	Major metabolic disorders in simple stomach animals

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	08	24	48	80

Recommended Books/Readings

Text Book:

1. Guoyao Wo. 2017. Principles of Animal Nutrition. First Edition. CRC Press, Taylor and Francis Group.

Reference Books:

1. P. McDonalds, R. A. Edwards, J. F. D. Greenhalgh, C. A. Morghan, L. A. Sinclair, R. G. Wilkinson. 2010. Animal Nutrition. 7th Edition. Pearson Publications. United Kingdom.
2. Wilson G. Pond. 2005. Basic Animal Nutrition and Feeding. 5th Edition. Wiley Publishers, USA.
3. David L. Nelson & Michal M. Cox. 2000. Lehninger Principles of Biochemistry. 3rd Edition, Wroth Publishers, USA.
4. S.A. Lanham-New, I.A. Macdonald, H.M. Roche. 2011. Nutrition and Metabolism. The Nutrition Society Textbooks, Wiley-Blackwell. (ISBN: 978-1-4051-6808-3).

Course Title: Energy Metabolism

Course No: NUTR-1032

Course Duration: 1 semester (16 weeks)

Credit hours: 3(2-1)

Course Description

Contents of this course have been designed for understanding of different laws of thermodynamics. Basic learning of partitioning of energy within animal body will also be part of contents. Students will also learn techniques for measurement of energy for different functions as well as energy systems available for livestock and poultry.

Performance Objectives

Objective 1

To study different laws of thermodynamics.

Objective 2

Understanding of bioenergetics and energy homeostasis.

Objective 3

To learn about strategies for measurement of energy yields for different functions.

Course Contents

Theory:

Energy metabolism in relation to animal nutrition. First and second law of thermodynamics. Bioenergetics. Energy homeostasis and factors affecting it. Methods for determining energy budgets. Feed energy, its partitioning and factors effecting it. Kinetics of carbohydrates, fats and proteins metabolism. Calorigenic effect and caloric protein relationship. Synthesis of body constituents. Fasting energy metabolism and basal metabolism. Measurements of energy need through BMR for maintenance, growth, reproduction, production and work. Energy systems for livestock and poultry. Hormonal regulation of energy metabolism.

Practical:

Determination of gross energy of feed ingredients by using bomb calorimeter. Determination of metabolizable energy of different feed ingredients in poultry in bio-digestibility laboratory.

Detail Course Outline

Serial No	Theory	Serial No	Practical
01	Zeroth law of thermodynamics	01	Introduction to bomb calorimeter
02	1 st law of thermodynamics	02	Determination of gross energy in livestock feed ingredients
03	2 nd law of thermodynamics	03	Determination of gross energy in livestock feed ingredients

04	3 rd law of thermodynamics	04	Determination of gross energy in poultry feed ingredients
05	Energy metabolism in relation to animal nutrition	05	Determination of gross energy in poultry feed ingredients
06	Bioenergetics in livestock	06	Determination of metabolizable energy in livestock
07	Bioenergetics in livestock	07	Determination of metabolizable energy in poultry
08	Energy homeostasis in animal body	08	Determination of metabolizable energy of different feed ingredients in poultry bio-digestibility laboratory (week-1)
09	Factors effecting energy homeostasis	09	Determination of metabolizable energy of different feed ingredients in poultry bio-digestibility laboratory (week-2)
10	Methods for determining energy budes	10	Determination of metabolizable energy of different feed ingredients in poultry bio-digestibility laboratory (week-3)
11	Methods for determining energy budes	11	Determination of metabolizable energy of different feed ingredients in poultry bio-digestibility laboratory (week-4)
12	Partitioning of feed energy in animal body	12	Analysis of faecal samples of poultry to calculate metabolizable energy of test ingredients (Dry Matter)
13	Factors effecting energy partitioning	13	Analysis of faecal samples of poultry to calculate metabolizable energy of test ingredients (Sample Preparation)
14	Kinetics of soluble carbohydrate metabolism	14	Analysis of faecal samples of poultry to calculate metabolizable energy of test ingredients (Energy Determination)
15	Kinetics of complex carbohydrate metabolism	15	Calculation of TDN
16	Kinetics of fat metabolism	16	Energy balancing in feed formulation
17	Kinetics of protein metabolism		
18	Energy protein relationship and its impact on animal performance		
19	Synthesis of body constituents		
20	Basal metabolism		
21	Fasting energy metabolism		
22	Measurement of energy need through BMR		
23	Energy requirements for maintaince, growth and production in livestock		

24	Energy requirement for growth and egg production in poultry		
25	Energy systems for livestock		
26	Energy systems for livestock		
27	Energy systems for poultry		
28	Energy systems for poultry		
29	Hormonal control of energy metabolism		
30	Hormonal control of energy metabolism		
31	Disorders of energy metabolism		
32	Disorders of energy metabolism		

Teaching learning strategies

Theory	Practical
Lectures	Performance
Presentation	Presentations
Group discussion	Group discussion
Assignments	Assignments
Quiz	

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks	04	12	24	40	12	08	20

Recommended Books/Readings

Textbook:

1. P. McDonald, R.A. Edwards, J.F.D. Greenhalgh, C.A. Morghan, L.A. Sindair, R.G. Wilkison. 2010. Animal Nutrition. Seventh Edition.

Reference Books:

1. D. A. BENDER. 2002. Introduction to Nutrition and Metabolism. Third Edition.
2. J.P.F. D'Mello. 2000. Farm Animal Metabolism and Nutrition. Biotechnology Department, the Scottish Agricultural College, Edinburg, UK.
3. R.J. Hughes. 2003. Energy Metabolism of Chickens Physiological Limitations; A report for the rural industries, research and development corporation.
4. P.R. Cheeke. 2005. Applied Animal Nutrition. 3rd Edition. Pearson Education (US).
5. P.J. Van Soest. 1994. Nutritional Ecology of Ruminants. Second Edition. Comstock Publishing Associate, Cornell University Press, Ithaca, N.Y.USA.

Course Title: Nutrition of Layers

Course No: NUTR-1033

Course Duration: 1 semester (16 weeks)

Credit hours: 3(2-1)

Course Description

This course has been designed to learn about different feeding strategies of layer birds to get economic benefits. Moreover, recent trends in layer nutrition will be acquainted to students.

Performance Objectives

Objective 1

To learn digestion and metabolism of nutrients in layers.

Objective 2

To study recent trends in layer nutrition.

Course Contents

Theory

Process of digestion and absorption of nutrients in layers. Nutrients requirements of commercial and breeders layers. Feed resources of layers and their nutritional profile. Feeding programs during brooding, growing and laying phases. Qualitative feed restriction. Molting of commercial and breeders layers. Effect of feed on egg quality and production. Effect of P & Ca ratio and amino acid-energy ratio on egg production. Role of feed additives in layer feed. Nutritional deficiencies/diseases in layers. Performance, feeding management during hot climate. Separate sex feeding. **Lysozymes as antimicrobial in layer diets. Concept of microbial protein. Nutrition of Day old layer chicks.** Use of nano technology in layer ration. Nutritional strategies to produce designer eggs. Use of nutraceuticals in layers ration. Use of botanicals to gut health and egg production in layers. Daily calcium cycles for layers.

Practical

Identification, classification & characteristics of common feed ingredients. Evaluation of different types of layer feed. Feed formulation. Practical feeding of breeder and layer flocks. Visits to breeder and commercial layer farms. Concept of synthetic amino acids in balancing the layer diets. Formulations on basis of digestible amino acids instead of total amino acids.

Detail Course Outline

Serial No	Theory	Serial No	Practical
01	Feed resources and their nutritional profile	01	Identification of feed stuffs and their nutritive values
02	Nutritional requirements of layers	02	Physical evaluation of feed stuffs
03	Nutritional requirements of Layer breeders	03	Evaluation of different types of layer feed

04	Feeding programs during brooding and growing	04	Energy and protein sources for layer diets
05	Feeding program during laying phases	05	Nutritional profile of corn and sorghum
06	Process of digestion and absorption of carbohydrates in layers	06	Nutritional profile of wheat, rice and rice polishing
07	Process of digestion and absorption of lipids in layers	07	Nutritional profile of SBM and rapeseed meal
08	Process of digestion and absorption of proteins in layers	08	Nutritional profile of canola meal and sunflower meal
09	Qualitative feed restrictions	09	Anti-nutritional factors of different feed ingredients
10	Molting of breeder layers	10	pH and Retention time of feed in different parts of GIT
11	Effect of feed on egg quality	11	Practical feeding of layer and breeder flocks.
12	Effect of Ca. & P ratio on egg production	12	Concept of synthetic amino acids in balancing the layer diets
13	Effect of amino acid energy ratio on egg production	13	Formulation on basis of digestible amino acids instead of total amino acids
14	Role of feed additives in layer feed	14	Practical demonstration on feed formulation
15	Use of nano technology in layer ration	15	Visit to commercial layer farm
16	Nutritional strategies to produce designer eggs	16	Visit to layer breeder farm
17	Use of nutraceuticals in layers ration		
18	Nutritional deficiency diseases in layers		
19	Feeding management of layers during hot climate		
20	Separate sex feeding		
21	Lysozyme as antimicrobial in layer diet		
22	Impact on feed form on layer production		
23	Concept of microbial proteins		
24	Use of botanicals to gut health and egg production in layers		
25	Recent trends in layer nutrition		
26	Water requirement and its quality for layer birds		
27	Micro-minerals in layer nutrition		
28	Macro-minerals in layer nutrition		
29	Fat and water soluble vitamins in layer nutrition		
30	Daily calcium cycles for layers		

31	Concept of ideal proteins		
32	Impact of mycotoxins of egg production		

Teaching learning strategies

Theory	Practical
Lectures	Performance
Presentation	Presentations
Group discussion	Group discussion
Assignments	Assignments
Quiz	

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks	04	12	24	40	12	08	20

Recommended Books/Readings

Textbook:

1. Lesson, S and J.D Summers. 2002 Scott's Nutrition of the chicken. International Book Distributing Co. Guelph Ontario, Canada.

Reference Books:

1. Rick Kleyn 2013. Chicken Nutrition: A Guide for Nutritionists and Poultry Professionals.
2. Granswothy, P.C and J. Wiseman. 2012. Recent advances in animal nutrition.
3. Lesson, S and J.D Summers. 2009. Commercial poultry nutrition. International Book Distributing Co. Guelph Ontario, Canada.
4. Reddy Y.R and T. Bhosale. 2004. Handbook of poultry nutrition.
5. Nutrient Requirements of Poultry. 1994. 9th Revised Edition. National Academy Press, Washington, D.C.
6. Lesson, S and J.D Summers. 1991. Commercial poultry Nutrition University Books, Guelph Ontario, Canada.

Course Title: Nutrition of Beef Animals

Course No: NUTR-1034

Course Duration: 1 semester (16 weeks)

Credit hours: 3(2-1)

Course Description

This course will incorporate knowledge about rumen ecology, microbial functions and fermentation processes. Different strategies related with feeding of beef cattle will also be introduced. Different digestibility techniques and feed formulation for various classes of beef animals will also be taught in this course.

Performance Objectives

Objective 1

To study different pathways occurring in rumen ecosystem.

Objective 2

To learn about recent trends in beef cattle nutrition.

Course Contents

Theory:

Digestive physiology, digestion and absorption. Factors affecting digestion. Feed resources; fodders, crop residues and concentrates and non-conventional feed resources. Nutritional requirements of male buffalo and cow calves. Requirements for maintenance, growth and feedlot fattening. Nutrition of breeding animals. Feeding systems; total mixed ration, forage plus supplementation, grazing plus supplementation, silage, haylage and hay etc. Ration formulation for veal and beef production. Feeding of indigenous beef breeds. Nutritional disorders and deficiency problems. Feed additives and supplements. Use of urea and other NPN sources for beef animals.

Practical:

Digestion trials; total tract digestibility technique, *In-sacco* digestibility techniques in dairy animals, Digestibility using markers. Feed formulation for various classes of beef animals: manual feed formulation, computerized feed formulation, Excel, CPM Dairy, NRC 2001. Hay and silage preparation. TMR particle size evaluation. Rumen sampling techniques; rumen pH, rumen ammonia estimation. Proximate analysis of feedstuffs for beef animals. Visits to feedlots.

Detail Course Outline

Serial No	Theory	Serial No	Practical
01	Digestive physiology	01	Total tract digestibility technique

02	Digestion and absorption in beef animals	02	<i>In-Sacco</i> digestibility technique
03	Factors affecting digestion	03	Digestibility measurement by using makers technique
04	Feed resources for beef animals	04	Introduction to feed formulation for beef animals
05	Non-conventional feed resources for beef animals	05	NRC, 2001 recommendations for nutritional requirements of beef animals
06	Nutritional requirements of male buffalo calves	06	Manual feed formulation technique
07	Nutritional requirements of male cow calves	07	Feed formulation by using Excel sheet
08	Nutrient requirements for maintenance of beef animals	08	Use of CPM software for feed formulation
09	Nutrient requirements for growth of beef animals	09	Hay Preparation
10	Nutrient requirements for feedlot fattening	10	Silage Preparation
11	Nutrition of breeding animals	11	TMR particle size evaluation
12	Nutrition of breeding animals	12	Rumen sampling techniques
13	Introduction to feeding systems for beef animals	13	Rumen pH Estimation
14	Total mixed ration system	14	Rumen ammonia estimation
15	Forage plus supplementation system	15	Proximate analysis of feedstuffs for beef animals
16	Silage Feeding	16	Proximate analysis of feedstuffs for beef animals
17	Hay and haylage feeding		
18	Ration formulation for veal production		
19	Ration formulation for beef production		
20	Ration formulation for beef production		
21	Feeding of indigenous beef breeds		
22	Feeding of indigenous beef breeds		
23	Nutritional disorders in beef animals		
24	Nutritional disorders in beef animals		
25	Feed additives and supplementation in beef animals		
26	Feed additives and supplementation in beef animals		
27	Micro-minerals feeding to beef animals		

28	Macro-minerals feeding to beef animals		
29	Vitamins feeding to beef animals		
30	Use of urea and other NPN sources in beef animals diet		
31	Use of urea and other NPN sources in beef animals diet		
32	Recent trends in beef nutrition		

Teaching learning strategies

Theory	Practical
Lectures	Performance
Presentation	Presentations
Group discussion	Group discussion
Assignments	Assignments
Quiz	

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks	04	12	24	40	12	08	20

Recommended Books/Readings

Text Book:

1. Mario De Beni Arrigoni, Rodrigo Dias Lauritano Pacheco. 2016. Rumenology. Springer International Publishing.

Reference Books:

1. Church, D.C. 1988. Ruminant Animal Digestive Physiology and Nutrition. Prentice Hall, New Jersey, USA.

3. Minson, D.J. 1990. Forage in Ruminant Nutrition. Harcourt Brae Jovanovich Publishers, New York, USA.
4. Wilson G. Pond. 2005. Basic Animal Nutrition and Feeding. 5th Edition. Wiley Publishers, USA.
5. P. McDonalds, R. A. Edwards, J. F. D. Greenhalgh, C. A. Morghan, L. A. Sinclair, R. G. Wilkinson. 2010. Animal Nutrition. 7th Edition. Pearson Publications. United Kingdom
6. Robert Blair. 2011. Nutrition and Feeding of Organic Cattle. CAB International. ISBN 978-1-84593-758-4.

Course Title: Vitamins in Animal Nutrition

Course No: NUTR-1035

Course Duration: 1 semester (16 weeks)

Credit hours: 2(2-0)

Course Description

This course has been designed to incorporate knowledge about different type of vitamins, their digestion, metabolism, antagonistic effects. Impact of hyper-vitaminosis and interaction of vitamins with other nutrients will be covered in this course. Students will be introduced about stability of vitamins under different storage conditions.

Performance Objectives

Objective 1

To study classification of different types of vitamins.

Objective 2

To study digestion and metabolism of vitamins.

Objective 3

To learn about antagonistic and synergetic effect of vitamins.

Course Contents

Theory:

History and development of the vitamins in animal nutrition and their classification. Fat-soluble vitamins: A,D,E, and K; sources, chemistry, metabolism, functions, antagonistic, deficiency, requirements and hypervitaminosis. Water-soluble vitamins: B-complex and C; sources, chemistry, functions, antagonist, metabolism, deficiency and requirements. Stability of vitamins under different storage conditions. Interaction of vitamins with other nutrients.

Detail Course Outline

Serial No	Theory
01	Classification of different types of vitamins
02	History and development of vitamins in Animal Nutrition
03	Functions of fat soluble vitamins in large animals
04	Functions of fat soluble vitamins for poultry birds
05	Functions of water soluble vitamins for large animals
06	Functions of water soluble vitamins for poultry birds
07	Digestion and absorption of Vit. A
08	Digestion and absorption of Vit. D
09	Digestion and absorption of Vit. E
10	Digestion and absorption of Vit. K
11	Utilization of Vit.B1 (thiamine) in Animal body
12	Digestion and absorption of Vit.B2 (Riboflavin)

13	Digestion and absorption of Vit.B3 (Niacin)
14	Digestion and absorption of Vit.B5 (Pantothenic acid)
15	Digestion and absorption of Vit.B6 (Pyridoxine)
16	Digestion and absorption of Vit.B7 (Biotin)
17	Digestion and absorption of Vit.B9 (folic acid)
18	Digestion and absorption of Vit.B12 (Cobalamin)
19	Digestion and absorption of Vit.C
20	Metabolism of fat soluble vitamins
21	Metabolism of water soluble vitamins
22	Deficiency symptoms of fat soluble vitamins in large animals
23	Deficiency symptoms of water soluble vitamins in large animals
24	Deficiency symptoms of fat soluble vitamins in Poultry
25	Deficiency symptoms of fat soluble vitamins in poultry
26	Hyper-vitaminosis in large animals
27	Hyper-vitaminosis in poultry birds
28	Antagonistic effects of vitamins
29	Interaction of vitamins with minerals
30	Interaction of vitamins with other nutrients
31	Stability of fat soluble vitamins under different storage conditions
32	Stability of water soluble vitamins under different storage conditions

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	04	12	24	40

Recommended Books/Readings

Text Book:

1. Lee Russell McDowell. 2000. Vitamins in Animal and Human Nutrition. 2nd Edition. Iowa State University Press, 2121 South State Avenue, Ames, Iowa.

Reference Books:

1. P. McDonalds, R. A. Edwards, J. F. D. Greenhalgh, C. A. Morghan, L. A. Sinclair, R. G. Wilkinson. 2010. Animal Nutrition. 7th Edition. Pearson Publications. United Kingdom.
2. S.A. Lanham-New, I.A. Macdonald, H.M. Roche. 2011. Nutrition and Metabolism. The Nutrition Society Textbooks, Wiley-Blackwell. (ISBN: 978-1-4051-6808-3).

Course Title: Nutrition of Indigenous and Rural Poultry**Course No: NUTR-1036****Course Duration: 1 semester (16 weeks)****Credit hours: 3(2-1)****Course Description**

Course contents will incorporate knowledge of nutrient requirement of different rural and indigenous poultry birds. Students will also be familiarise with nutritional deficiency diseases and software related with feed formulation.

Performance Objectives**Objective 1**

Introduction about nutrient requirement of different rural poultry birds

Objective 2

Effect of feed on meat quality, egg production and nutrition related diseases.

Detail Course Outline**Course Contents:****Theory:**

Nutrient requirements and feeding systems of Indigenous poultry i.e., Turkey, Geese, Ducks, Pheasants, Quails and desi birds. Macro and micro nutrient demands and availability. Signs of nutritional deficiencies of indigenous and other poultry. Feed resources and their availability and nutritional profile. Feed supplementation. Effect of feed on meat quality and egg production. Nutrition related diseases in indigenous poultry.

Practical:

Feed formulation by using computer software. Proximate analysis of feeds offered to Indigenous birds. Visits/Survey reports of indigenous poultry.

Serial No	Theory	Serial No	Practical
01	Nutritional requirements of turkeys	01	Estimation of dry matter in indigenous bird's feed
02	Nutritional requirements of geese and ducks	02	Estimation of crude protein in indigenous bird's feed
03	Nutritional requirements of pheasants	03	Estimation of crude fat in indigenous bird's feed
04	Nutritional requirements of quail	04	Estimation of crude fibre in indigenous bird's feed
05	Nutritional requirements of desi birds	05	Estimation of ash contents in indigenous bird's feed
06	Nutritional deficiencies in turkey	06	Estimation of NFE in indigenous bird's feed

07	Nutritional deficiencies in geese and ducks	07	Estimation of mineral contents in indigenous bird's feed
08	Nutritional deficiencies in pheasants	08	Estimation of aflatoxins in indigenous bird's feed
09	Nutritional deficiencies in quail	09	Estimation of anti-nutritional factors in indigenous bird's feed
10	Nutritional deficiencies in desi birds	10	Feed formulation for turkeys by using computer software
11	Feed resources for indigenous birds	11	Feed formulation for ducks and geese by using computer software
12	Nutritional profile of available feed resources	12	Feed formulation for Quail by using computer software
13	Impact of feed on meat quality	13	Feed formulation for desi chicken and pheasants by using computer software
14	Impact of feed of egg production	14	pH and Retention time of feed in different parts of GIT
15	Concept of feed supplementation	15	Practical feeding of indigenous poultry birds
16	Use of feed additives in indigenous poultry	16	Advances and future directions in indigenous poultry bird's nutrition
17	Use of feed additives in indigenous poultry		
18	Micro-mineral nutrition of indigenous birds		
19	Macro-mineral nutrition of indigenous birds		
20	Fat soluble vitamins in indigenous birds		
21	Water soluble vitamins in indigenous birds		
22	Digestion and absorption of Carbohydrates in indigenous birds		
23	Digestion and absorption of Carbohydrates in indigenous birds		
24	Digestion and absorption of lipids in indigenous birds		
25	Digestion and absorption of lipids in indigenous birds		
26	Digestion and absorption of proteins in indigenous birds		
27	Digestion and absorption of proteins in indigenous birds		
28	Importance of water quality for indigenous birds		
29	Recent trends in feeding of indigenous poultry birds		
30	Role of synthetic amino acids in indigenous poultry birds nutrition		

31	Impact of mycotoxins of performance of indigenous poultry		
32	Impact of anti-nutritional factors on production of indigenous poultry		

Teaching learning strategies

Theory	Practical
Lectures	Performance
Presentation	Presentations
Group discussion	Group discussion
Assignments	Assignments
Quiz	

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks	04	12	24	40	12	08	20

Recommended Books/Readings

Text Books:

1. S. Lesson, J.D. Summers. 2005. Commercial Poultry Nutrition. 3rd Edition. Published by Nottingham University Press, Manor Farm, Church Lane, Thrumpton, Nottingham, NG11 0AX, England.

Reference Books:

1. Donald D. Bell, William D. Weave. 2002. Commercial Chicken Meat and Egg Production. 5th Edition. Kluwer Academic Publishers. ISBN: 978-0-7923-7200-4.
2. Wilson G. Pond. 2005. Basic Animal Nutrition and Feeding. 5th Edition. Wiley Publishers, USA.
3. G. C. Perry. 2003. Welfare of the Laying Hens. Poultry Science Symposium series. Vol. 27. CAB International. ISBN 0-185199-813-5.

Course Title: Equine Nutrition

Course No: NUTR-1037

Course Duration: 1 semester (16 weeks)

Credit hours: 2(2-0)

Course Description

Course has been designed with basic aims to learn about digestive physiology, nutritional requirements and feeding practices related with equines. Concepts of utilization of feed additives and supplementation in feeding of these species will also be communicated to students.

Performance Objectives

Objective 1

To study about digestive physiology and nutritional requirements of various classes of equines.

Objective 2

To learn about nutritional and deficiency diseases.

Course Contents

Theory

Digestive physiology: Digestion and absorption. Factors affecting digestion in horses. Feed resources, Fodders, grazing and concentrates. Nutritional requirements of various classes of horses. Requirement for maintenance, work, pregnancy, lactation, growth. Feeding system, grazing plus supplementation, fodder plus supplementation. Special feeding of obese, sick and show horses. Nutritional disorders and deficiency diseases. Feed additives and supplements. Feeding of donkeys, mules and ponies.

Detail Course Outline

Serial No	Theory
01	Nutritional requirements for maintenance of various classes of horses
02	Nutritional requirements for work of various classes of horses
03	Nutritional requirements for lactation of various classes of horses
04	Nutritional requirements for pregnancy for various classes of horses
05	Nutritional requirements for growth of various classes of horses
06	Digestion of proteins in horses
07	Digestion of fats in horses
08	Digestion of carbohydrates in horses
09	Factors effecting digestion in horses
10	Importance of water in equines
11	Feed resources for different equine species
12	Impact of grazing on equine performance
13	Impact of supplementation on performance of equine species
14	Special feeding for sick horse

15	Special feeding for race and show horses
16	Nutritional disorders in equines
17	Nutritional disorders in equines
18	Use of feed additives in equine ration
19	Use of feed additives in equine ration
20	Feeding of donkeys
21	Feeding of mules
22	Management of heat stress in equines
23	Metabolic disorders in equines
24	Role of hormones in metabolism of equines
25	Basal metabolic rate for equines
26	Research techniques in equine nutrition
27	Importance of mineral nutrition for equine species
28	Importance of vitamins nutrition for equine nutrition
29	Nutrition and reproduction in equines
30	Round the year fodder management for equines
31	Feeding management for scarcity period in equines
32	Advancement in equine nutrition

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	04	12	24	40

Recommended Books/Readings

Text Book:

1. **Zoe Davies. 2009.** Introduction to Horse Nutrition. **Wiley Blackwell. A John Wiley and Sons, Ltd. Publications, Australia.**

Reference Books:

1. P.R. Cheeke. 2005. Applied Animal Nutrition. 3rd Edition. Pearson Education (US).
2. Joe D. Pagan and R.J. Geor. 2002. Advances in Equine Nutrition -2. Empress Publishing the Netherlands.
3. NRC. 1998. Nutrient Requirements of Horses. National Research Council, National Academy Press, Washington, D.C., USA.

Course Title: Camel Nutrition

Course No: NUTR-1038

Course Duration: 1 semester (16 weeks)

Credit hours: 2(2-0)

Course Description

Course has been designed with basic aims to learn about digestive physiology, nutritional requirements and feeding practices related with camels. Concepts of utilization of feed additives and supplementation in feeding of this specie will also be communicated to students.

Performance Objectives

Objective 1

To study about digestive physiology and nutritional requirements of camels.

Objective 2

To learn about nutritional and deficiency diseases.

Course Contents

Theory:

Digestive physiology: Digestion and absorption. Factors affecting digestion in camel. Feed resources, grazing Shrubs, trees, fodders, and concentrates. Nutritional requirements for maintenance, growth, lactation. Pregnancy and work. Feeding system, grazing plus supplementation, fodder plus supplementation. Nutritional disorders and deficiency diseases. Feed additives and supplements. Feeding for beef production, race camel.

Detail Course Outline

Serial No	Theory
01	Nutritional requirements for maintenance of various classes of camels
02	Nutritional requirements for work of various classes of camels
03	Nutritional requirements for lactation of various classes of camels
04	Nutritional requirements for pregnancy for various classes of camels
05	Nutritional requirements for growth of various classes of camels
06	Digestion of proteins in camels
07	Digestion of fats in camels
08	Digestion of carbohydrates in camels
09	Factors effecting digestion in camels
10	Importance of water in camels
11	Feed resources for different camel species
12	Impact of grazing on camel performance
13	Impact of supplementation on performance of camel species
14	Special feeding for sick camel
15	Special feeding for race and show camels
16	Nutritional disorders in camels

17	Nutritional disorders in camels
18	Use of feed additives in camel ration
19	Use of feed additives in camel ration
20	Feeding of young camels
21	Feeding of beef camels
22	Management of heat stress in camels
23	Metabolic disorders in camels
24	Role of hormones in metabolism of camels
25	Basal metabolic rate for camels
26	Research techniques in camel nutrition
27	Importance of mineral nutrition for camel species
28	Importance of vitamins nutrition for camel nutrition
29	Nutrition and reproduction in camels
30	Round the year fodder management for camels
31	Feeding management for scarcity period in camels
32	Advancement in camel nutrition

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	04	12	24	40

Recommended Books/Readings

Text Book:

1. Dr. Muhammad F. Wardeh. 1997. Nutrient Requirements of the Dromedary Camels. Published in Syrian Arab Republic.

Reference Books:

1. Yagil, R. Desert Camel. Comparative Physiological Adaptation (Comparative Animal Nutrition) Hard-Cover Edition.
2. Wilson, T. 1998. Camels. Published by MacMillan Education Ltd.

Course Title: Fish Nutrition

Course No: NUTR-1039

Course Duration: 1 semester (16 weeks)

Credit hours: 2(2-0)

Course Description

This course has been designed with basic aims to learn about digestive physiology, nutritional requirements and feeding practices of fish species. Concepts of utilization of feed additives and supplementation in feeding of these species will also be communicated to students.

Performance Objectives

Objective 1

To study about digestive physiology and nutritional requirements of fish.

Objective 2

To learn about nutritional and deficiency diseases.

Course Contents

Theory:

Digestion, absorption and metabolism of nutrients. Nutritional requirements of fish; different kinds of fish feeds. Feed resources, availability and nutrient profile of feed ingredients. Feed formulation, handling and storage of feed. Feeding systems. Feeding of aquarium fish. Nutritional disorders and diseases of fish. Feed additives and supplements.

Detail Course Outline

Serial No	Theory
01	Introduction to digestive system of different species of fish
02	Digestion of feeds in different types of fish
03	Digestion of feeds in different types of fish
04	Absorption of nutrients in different types of fish
05	Absorption of nutrients in different types of fish
06	Metabolism of nutrients in different types of fish
07	Metabolism of nutrients in different types of fish
08	Nutritional requirements of different species of fish
09	Nutritional requirements of different species of fish
10	Different kinds of fish feeds
11	Different kinds of fish feeds
12	Feed resources for fish feeds
13	Feed resources for fish feeds
14	Availability and nutrient profiling of feed ingredients for fish feeds
15	Availability and nutrient profiling of feed ingredients for fish feeds
16	Availability and nutrient profiling of feed ingredients for fish feeds
17	Feed formulation for fish

18	Feed formulation for fish
19	Feed formulation for fish
20	Handling and storage of fish feed
21	Handling and storage of fish feed
22	Feeding systems for fish species
23	Feeding systems for fish species
24	Feeding of aquarium fish
25	Feeding of aquarium fish
26	Nutritional disorders and deficiency diseases of fish
27	Nutritional disorders and deficiency diseases of fish
28	Feed additives and supplements in fish feed
29	Feed additives and supplements in fish feed
30	Importance of micro and macro minerals in fish nutrition
31	Vitamins in fish nutrition
32	Recent advances in fish nutrition

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	04	12	24	40

Recommended Books/Readings

Text Books:

1. Jean Guillaume, Praxis Publishing, Sadasivam Kaushik, Pierre Bergot, Robert Metaille. 2001. Nutrition and Feeding of Fish and Crustaceans. Praxis Publishing Limited. Chichester, UK.

Reference Books:

1. G. Joan Holt. 2011. Larval Fish Nutrition. The Nutrition Society Textbooks, Wiley-Blackwell.
2. Shepherd C.J. and N.R. Bromage, 1998. Intensive Fish Farming. B.S.P. Professional Books, Oxford, London.
3. NRC. 1993. Nutrient Requirements of Warm Water Fishes and Shell Fishes. National Research Council National Academy Press Washington D.C. USA.
4. Goddard, S. 1996. Feed Management in Intensive Aquaculture. Champan and Hall, New York, USA.

Course Title: Feed Biotechnology

Course No: NUTR-1040

Course Duration: 1 semester (16 weeks)

Credit hours: 2(2-0)

Course Description

This course has been designed with basic aims to learn about the role of biotechnological advances in animal nutrition. Concepts of production and usage of feed additives and supplementation materials in feeding ruminants and poultry will also be communicated to students.

Performance Objectives

Objective 1

To learn about importance of biotechnology in animal nutrition

Objective 2

To learn about production of feed additives and fungal biotechnology

Course Contents

Theory

Application of biotechnology to increase the nutritional composition and safety of animal feed. Approaches to increase the nutritional value of feedstuffs and/or the sustainability of feed production. Types of fermentation. Production of feed additives. Enzyme technology, biocatalysis and bioprocess technology. Production techniques used in fungal biotechnology. Metabolites produced by fungi and impact on animal/poultry health. Role of synthetic peptides/proteins in animal feeding. Use of monoclonal antibodies as a diagnostic/therapeutic. Production of Phytogenic substances as alternatives of antibiotics by using biotechnological tools. Use of Nano-biotechnology in animal and poultry feeding. Ethical and social issues in animal biotechnology.

Detail Course Outline

Serial No	Theory
01	Introduction to biotechnology
02	Interrelation between biotechnology and animal nutrition
03	Use of biotechnology for safety of animal feed
04	Use of biotechnology for safety of animal feed
05	Approaches to increase the nutritional value of feedstuffs
06	Approaches to improve the sustainability of feed production
07	Types of fermentation
08	Types of fermentation
09	Production of feed additives

10	Production of feed additives
11	Enzyme technology, bio-catalysis and bioprocess technology
12	Enzyme technology, bio-catalysis and bioprocess technology
13	Production techniques used in fungal biotechnology
14	Production techniques used in fungal biotechnology
15	Metabolites produced by fungi
16	Metabolites produced by fungi
17	Effects of fungal metabolites on ruminants health
18	Effects of fungal metabolites on poultry health
19	Role of synthetic peptides/proteins in animal feeding
20	Role of synthetic peptides/proteins in animal feeding
21	Use of monoclonal antibodies as a diagnostic tool
22	Use of monoclonal antibodies as a therapeutic tool
23	Production of Phytogenic substances as alternatives of antibiotics by using biotechnological tools
24	Production of Phytogenic substances as alternatives of antibiotics by using biotechnological tools
25	Use of Nano-biotechnology in Ruminants feeding
26	Use of Nano-biotechnology in poultry feeding
27	Ethical and social issues in animal biotechnology
28	Ethical and social issues in animal biotechnology
29	Role of feed additives in advancement of ruminant industry
30	Role of feed additives in advancement of ruminant industry
31	Role of feed additives in advancement of poultry industry
32	Role of feed additives in advancement of poultry industry

Teaching learning strategies

Theory
Lectures
Presentation
Group discussion
Assignments
Quiz

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory				
Modality	Assignment	Mid term	Final Term	Total
Max Marks	04	12	24	40

Recommended Books/Readings

Text Book:

1. Dilip K. Arora. 2003. Fungal Biotechnology in Agricultural, Food, and Environmental Applications. 1st Edition. CRC press. ISBN 9780824747701 - CAT# DK2916.

Reference Books:

1. Michael R Bedford, Gary G. Partridge. 2010. Enzymes in Farm Animal Nutrition. 2nd Edition. CAB International. ISBN 978-1-84593-674-7. 1st Edition published in 2001.

2 . P.R. Cheeke. 2005. Applied Animal Nutrition. 3rd Edition. Pearson Education (US).

3. Leeson, S., G.J. Diaz and J.D. Summers. 1995. Poultry Metabolic Disorders and Mycotoxins. University Book, P.O. Box 1326, Guelph, Ont.NIH 6N8, Canada.

4. Caygill, C. and I.M. HJarvey. 2002. Secondary Plant Products. Empress Publishing. The Netherlands.

5. R. John Wallace, Andrew Chesson. 1995. Biotechnology in Animal Feeds and Animal Feeding. VCH Publishers, New York, USA.

Course Title: Nutrition of Pet and Zoo Animals

Course No: NUTR-1041

Course Duration: 1 semester (16 weeks)

Credit hours: 3(2-1)

Course Description

This course will help to incorporate advance knowledge about nutritional requirement in different species kept as pet or in zoo. Students will learn about their feed formulation, care and deficiency problems associated with different feeding practices.

Performance Objectives

Objective 1

To learn about nutrient requirements of pet and zoo animals

Objective 2

Nutritional deficiency diseases of pet and zoo animals

Course Contents

Theory:

Major nutrients and their metabolism: basic fundamentals of animal nutrition, various types of nutrients and their composition. Small and large pet animal's optimum requirements, natural foods for pets, feed supplements, their types, form and quality, feeding practices. Canine nutrition; Amounts of feed, form and quality, feeding practices. Canine nutrition: Amounts of feed, feeding requirements of orphaned puppies, methods of feeding, forms of dog food, types of dog food, feed requirement during geriatric care, Rx diets. Feline Nutrition: Methods of feeding; forms of cat food, types of cat food, a mounts of feed. Important nutritionally caused diseases of dog and cat. Use of roughages in wild animals, toxic substances; nutritional requirements of various groups' of vertebrates. Amphibian and Reptile Nutrition, Bird nutrition, general nutrition of mammals, Equine nutrition, Rabbit and Rodent nutrition, Fur-bearing nutrition, Nutritional care of orphaned animals. Nutritional requirements of aged animals, Nutritional care for diseased animals.

Practical:

Determine the nutritional value of various foodstuffs. Feed manufacturing and diet formulation of different species of vertebrate, Feed analysis.

Detail Course Outline

Serial No	Theory	Serial No	Practical
01	Basic fundamentals of animal nutrition	01	Determination of nutritional value of various feedstuffs
02	Major nutrients and their metabolism	02	Determination of nutritional value of various feedstuffs

03	Various type of nutrients and their composition for pet and zoo animals	03	Diet formulation for various classes of pet animals
04	Various type of nutrients and their composition for pet and zoo animals	04	Diet formulation for various classes of pet animals
05	Small pet animal nutrient requirements	05	Diet formulation for various classes of zoo animals
06	Small pet animal nutrient requirements	06	Diet formulation for various classes of zoo animals
07	Large pet animals nutrient requirements	07	Feed manufacturing of various classes of pet animals
08	Large pet animals nutrient requirements	08	Feed manufacturing of various classes of pet animals
09	Natural foods for pets	09	Feed manufacturing of various classes of zoo animals
10	Feed supplements, their types, form and quality for pet animals	10	Feed manufacturing of various classes of zoo animals
11	Feed supplements, their types, form and quality for pet animals	11	Analysis of feed for dry matter contents
12	Canine Nutrition; amount of feed, form and quality	12	Analysis of feed for crude protein contents
13	Feeding practices for canines	13	Analysis of feed for crude fat contents
14	Amounts of feed and feeding requirement of orphaned puppies	14	Analysis of feed for crude fibre contents
15	Methods of feeding to canines	15	Analysis of feed for total ash contents
16	Forms and types of dog feed	16	Toxins analysis in pet and zoo animals feed
17	Feed requirements during geriatric care and treatment diets		
18	Feline nutrition		
19	Methods of feeding to felines		
20	Forms and types of cat foods		
21	Nutritionally caused diseases of dog and cats		
22	Use of roughages in wild animals		
23	Nutritional requirements of various groups of vertebrates		
24	Amphibian and reptile nutrition		
25	Rabbit and Rodents nutrition		
26	Fur-bearing nutrition		
27	Bird Nutrition		
28	Equine Nutrition		
29	General nutrition of mammals		
30	Nutritional care of orphaned animals		
31	Nutritional requirements of aged animals		

32	Nutritional care of diseased animals		
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Teaching learning strategies

Theory	Practical
Lectures	Performance
Presentation	Presentations
Group discussion	Group discussion
Assignments	Assignments
Quiz	

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks	04	12	24	40	12	08	20

Recommended Books/Readings

Text Book:

1. Linda P. Case, Leighann Daristotle, Michael G. Hayek, Melody Foess Raasch. 2011. Canine and Feline Nutrition: A Resource for Companion Animal Professionals. 3rd Edition. MOSBY ELSEVIER.

Reference Books:

1. NRC. 2006. Nutrient Requirements of Dogs and Cats. National Research Council, Division on Earth and Life Studies, Board on Agriculture and Natural Resources, Committee on Animal Nutrition, Subcommittee on Dog and Cat Nutrition.

2. [David Bastin](#), [Jennifer Ashton](#), [Grant Nixon](#). 2012. Better Food for Dogs: A Complete Cookbook & Nutrition Guide. Robert Rose Incorporated.

3. P.R. Cheeke. 2005. Applied Animal Nutrition. 3rd Edition. Pearson Education (US).

4. Charles T.R. 1983. Wildlife Feeding and Nutrition. Academic Press, New York, USA.
5. Hughes, R.N. 1993. Diet Selection: An Interdisciplinary Approach to Foraging Oxford: Blackwell, UK.

Course Title: Advanced Analytical Techniques in Animal Nutrition**Course No: NUTR-1042****Course Duration: 1 semester (16 weeks)****Credit hours: 3(0-3)****Course Description**

The objective of this course is to provide an exposure to modern analytical instruments and techniques being used in latest animal nutrition research. The course is designed to provide hands-on experience using chemical instrumentation through a combination of experiments and demonstrations. After completing this course, students will be able to use the latest equipment and instruments being used in animal nutrition research.

Performance Objectives**Objective 1**

To learn about latest techniques used in animal nutrition laboratories

Objective 2

Hands on practice on latest instruments in animal nutrition laboratory

Course Contents**Practical**

Amino acid analysis of feedstuffs. Use of Near Infrared Spectroscopy technique for analysis of ingredients and compound feeds. Gross Energy Estimation of ingredients and compound feeds by using bomb calorimeter. *In-vitro* digestibility studies by using Daisy incubator. Nitrogen estimation by Dumas Method. Crude fat estimation by using ANKOM technology. Crude fibre, ADF, NDF and reactive lignin estimation by ANKOM technology. Mineral estimation by using atomic absorption spectroscopy. Estimation of antibiotics and steroids by using UHPLC. Hormones analysis by using ELISA technique. Use of GC-MS for fatty acid analysis. Estimation of per oxide, TBA and free fatty acids.

Detail Course Outline

Serial No	Practical	Serial No	Practical
01	Amino acid analysis of feedstuffs	33	Macro-minerals estimation by using atomic absorption spectroscopy
02	Amino acid analysis of feedstuffs	34	Micro-minerals estimation by using atomic absorption spectroscopy
03	Amino acid analysis of feedstuffs	35	Micro-minerals estimation by using atomic absorption spectroscopy
04	Use of Near Infrared Spectroscopy technique for analysis of ingredients and compound feeds	36	Micro-minerals estimation by using atomic absorption spectroscopy

05	Use of Near Infrared Spectroscopy technique for analysis of ingredients and compound feeds	37	Estimation of antibiotics and steroids by using UHPLC
06	Use of Near Infrared Spectroscopy technique for analysis of ingredients and compound feeds	38	Estimation of antibiotics and steroids by using UHPLC
07	Gross Energy Estimation of ingredients and compound feeds by using bomb calorimeter	39	Estimation of antibiotics and steroids by using UHPLC
08	Gross Energy Estimation of ingredients and compound feeds by using bomb calorimeter	40	Hormones analysis by using ELISA technique.
09	Gross Energy Estimation of ingredients and compound feeds by using bomb calorimeter	41	Hormones analysis by using ELISA technique.
10	<i>In-vitro</i> digestibility studies by using Daisy incubator	42	Hormones analysis by using ELISA technique.
11	<i>In-vitro</i> digestibility studies by using Daisy incubator	43	Use of GC-MS for fatty acid analysis
12	<i>In-vitro</i> digestibility studies by using Daisy incubator	44	Use of GC-MS for fatty acid analysis
13	Nitrogen estimation by Dumas Method	45	Use of GC-MS for fatty acid analysis
14	Nitrogen estimation by Dumas Method	46	Estimation of per oxide, TBA and free fatty acids
15	Nitrogen estimation by Dumas Method	47	Estimation of per oxide, TBA and free fatty acids
16	Crude fat estimation by using ANKOM technology	48	Estimation of per oxide, TBA and free fatty acids
17	Crude fat estimation by using ANKOM technology		
18	Crude fat estimation by using ANKOM technology		
19	Estimation of crude fibre by ANKOM technology		
20	Estimation of crude fibre by ANKOM technology		
21	Estimation of crude fibre by ANKOM technology		
22	Estimation of ADF by using ANKOM technology		
23	Estimation of ADF by using ANKOM technology		
24	Estimation of ADF by using ANKOM technology		
25	Estimation of NDF by using ANKOM technology		

26	Estimation of NDF by using ANKOM technology		
27	Estimation of NDF by using ANKOM technology		
28	Estimation of reactive lignin by using ANKOM technology		
29	Estimation of reactive lignin by using ANKOM technology		
30	Estimation of reactive lignin by using ANKOM technology		
31	Macro-minerals estimation by using atomic absorption spectroscopy		
32	Macro-minerals estimation by using atomic absorption spectroscopy		

Teaching learning strategies

Practical
Performance
Presentations
Group discussion
Assignments

Class work Policies

- Equal opportunity
- Intellectual honesty
- Regularity and Punctuality
- Adherence to deadlines
- Fairness
- Conformity to discipline

Assessment Strategies

Theory					Practical		
Modality	Assignment	Mid term	Final Term	Total	Class performance	Final	Total
Max Marks					24	36	60

Recommended Books/Readings

Text Book:

1. S. Suzanne Nielson. 2017. Food analysis laboratory manual. 3rd Edition. [Springer International Publishing](#). ISBN- 9783319441252.

Reference Books:

1. S.P. Tiwari, S. Rajagopal, Usha Rani Mehra. 2012. Analytical Techniques in Animal Nutrition. Satish Serial Publishers. ISBN 13: 9789381226018.
2. Shaline Sehgal. 2016. A laboratory manual of food analysis. Kindle Edition. K International Publishing House. **ASIN:** B01F58FM36.
3. AOAC, 2000. Official Methods of Analysis of the Association of Official Analytical Chemists, 17th Ed. Vol. 1,2 Supplement. Arlington V.A.USA.